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(54) DATA TRANSMITTER AND DATA TRANSMISSION METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To improve more the quality of an OFDM modulation signal.

SOLUTION: A signal point transmitter 14 allocates a signal point Zkl in a QPSK modulation circuit 18 to parallel data S100 inputted from an S/P conversion circuit 100 by changing an amplitude so as to compensate an aperture effect of a communication transmission line and each section after an IFFT circuit 104 onto a modulation signal S20. D/A converter circuits 10611062 and LPF circuits 10811082 convert complex number data zkm into analog form and eliminate an undesired harmonic component to generate transmission signals S1061S1062. The QPSK modulation circuit 18 adopts the QPSK modulation system to generate a modulation signal S18 at an intermediate frequency band. A transmission circuit 20 converts the modulation signal S18 into a modulation signal S20 at a carrier frequency band of a communication transmission line to send it.

CLAIMS

[Claim(s)]

[Claim 1]It is data transmission equipment of an OFDM system characterized by comprising the followingData transmission equipment which assigns said each of two or more transmission data at a signal point of said prescribed quadrature

modulation method with which said signal point quota means gave an amplitude characteristic which compensates an aperture effect which said frequency domain and segment-of-time conversion method or subsequent ones give beforehand to said transmission signal.

A signal point quota means which assigns two or more transmission data of each which is the targets of transmission at a predetermined signal point of a prescribed quadrature modulation method.

A frequency domain and a segment-of-time conversion method which changes into a segment of time every 1 set of two or more of said transmission data assigned at a signal point respectively from a frequency domain

A D / A conversion means to change into analog format said two or more transmission data of a digital format changed into a segment of time and to generate a transmission signal.

An orthogonal modulation means which modulates a carrier signal of predetermined frequency with said generated transmission signal and is sent out to a predetermined communication transmission line with said prescribed quadrature modulation method.

[Claim 2] Said signal quota means matches and memorizes complex type-type [showing a signal point of said prescribed quadrature modulation method assigned to a bit string of two or more of said transmission data and said each of bit string of two or more of said transmission data] signal point data. The data transmission equipment according to claim 1 which outputs said signal point data according to said each of bit string of two or more of said transmission data inputted.

[Claim 3] A counting circuit which said signal quota means calculates the number of said bit strings of two or more of said transmission data inputted and supplies these enumerated data to said signal point memory measure. A reset circuit which resets enumerated data of said counting circuit whenever said bit string of 1 set of two or more of said transmission data is inputted. Said bit string of two or more of said transmission data and enumerated data of said counting means are used as address input data. The data transmission equipment according to claim 2 which has a memory circuit which memorizes said each of signal point data to a memory address which said each of address input data shows and outputs said signal point data according to said address input data.

[Claim 4] By two or more transmission data which was assigned at a signal point of said prescribed quadrature modulation method was changed into a segment of time from a frequency domain and was changed into analog format. It is a data transmission method of an OFDM system which becomes irregular with a prescribed quadrature modulation method and transmits two or more carrier signals of each of predetermined frequency. A data transmission method which assigns said each of two or more transmission data at a signal point of said prescribed quadrature modulation method which gave a predetermined amplitude characteristic beforehand so that an aperture effect given to said each of two or more transmission data in the case of said modulation process and transmission

may be compensated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention compensates the aperture effect given to a transmission signal inside data transmission equipment and relates to the data transmission equipment and the data transmission method which improved the transmission characteristic.

[0002]

[Description of the Prior Art] From the former as a modulating method at the time of transmitting digital data. For example the PSK (Phase Shift Keying) method to which the phase of a single carrier signal is changed according to the value of data and quadrature modulation method such as a QAM (Quadrature Amplitude Modulation) method which becomes irregular by changing the phase and amplitude of a carrier signal according to the value of data are used well.

[0003] The orthogonal frequency division multiplex method (OFDM system; Orthogonal Frequency Division Multiplexing) is proposed as a new modulating method at the time of transmitting digital data these days. This OFDM system modulates two or more carrier signals of each included in transmission frequency bandwidth by two or more data of each of a comparatively low data rate and generates two or more modulating signals and is [modulating signals] parallel and transmits these modulating signals.

[0004] In an OFDM system since transmission frequency bandwidth is divided into two or more carrier-signal correspondences and used the transmission band of per one modulating signal (carrier signal) becomes narrow and the transmission data rate per modulating signal cannot be made high compared with a QAM method etc. However since it can be parallel and two or more modulating signals can be transmitted the OFDM system can make the transmission data rate of the whole transmission frequency bandwidth equivalent to a QAM method etc.

[0005] Since the transmission data rate of an OFDM system per modulating signal is low the tolerance over a multipass ghost obstacle is high and it is suitable for the data communications through the wireless communications lines using a terrestrial wave.

For example it is observed as a transmission system for new digital television broadcast.

An OFDM system provides a television broadcasting office for two or more broadcasting areas of every These television broadcasting offices perform data distribution of digital television broadcast to each broadcasting areas using the radio wave signal of the same frequency It is observed also as a transmission system which can realize the SFN (Single Frequency Network) method which can use frequency resources effectively.

[0006] Although it is preferred for the modulation process and recovery processing in an OFDM system for fast Fourier transform processing and the fast Fourier inverse transformation processing to be applied and put in block and to perform them respectively, conventional realization of the device which can perform the Fourier conversion process and a Fourier reverse conversion process at high speed was difficult and the OFDM system was not necessarily practical. However, realization became possible in hardware at high speed about the Fourier conversion process and the Fourier reverse conversion process with improvement in digital-signal-processing art in recent years. That is, a majority of carrier signals [each of] are put in block by a majority of transmission data [each of] and it becomes irregular and much transmission data can be collectively recovered now from a majority of modulating signals [each of] and practicality of an OFDM system is increasing further.

[0007] When generating the transmission signal of an OFDM system, the circuit which needs to carry out the digital to analog of the transmission data which carried out fast Fourier inverse transformation and performs this digital to analog processing usually has a predetermined frequency characteristic and an aperture effect will be given to the transmission signal to generate. Thus, if the transmission signal with which the aperture effect was given digital to analog processing or on the communication transmission line is sent out to a communication line, the fault of an error rate increasing to the transmission data reproduced will arise.

[0008] Therefore, after compensating the aperture effect given to a transmission signal, it is necessary to carry out a transmission signal to a communication line. In order to compensate an aperture effect, the method of equalizing the transmission signal after changing into analog format conventionally through the filter which has a predetermined frequency characteristic etc. was taken. However, if a transmission signal is equalized and an aperture signal is equalized with a filter etc., the circuit structure of the circuit for performing equalization processing will become large, the miniaturization of transmission equipment and low cost-ization will be barred and also an aperture effect was not necessarily able to be compensated fully.

[0009] This invention is made in view of the problem of the conventional technology mentioned above and an object of this invention is to provide the data transmission equipment and the data transmission method which can raise more the quality of the modulating signal generated by an OFDM system. An object of this invention is to provide the data transmission equipment and data transmission equipment to which the data error rate of the transmission data reproduced from the modulating signal which passed through the communication line can be reduced.

[0010] An object of this invention is to provide the data transmission equipment and the data transmission method with which the aperture effect given to a modulating signal can fully be compensated when generating the transmission signal of an OFDM system. An object of this invention is to provide the data transmission equipment and the data transmission method which can generate the modulating signal of the quality OFDM system with which the aperture effect was

fully compensated with a device [that it is small and low cost].

[0011]

[Means for Solving the Problem]To achieve the above objectsdata transmission equipment concerning this inventionA signal point quota means which assigns two or more transmission data of each which is the targets of transmission at a predetermined signal point of a prescribed quadrature modulation methodA frequency domain and a segment-of-time conversion method which changes into a segment of time every 1 set of two or more of said transmission data assigned at a signal pointrespectively from a frequency domainWith a D / A conversion means to change into analog format said two or more transmission data of a digital format changed into a segment of timeand to generate a transmission signaland said prescribed quadrature modulation method. It is data transmission equipment of an OFDM system which has an orthogonal modulation means which modulates a carrier signal of predetermined frequency with said generated transmission signaland is sent out to a predetermined communication transmission lineSaid signal point quota means assigns said each of two or more transmission data beforehand at a signal point of said prescribed quadrature modulation method which gave an amplitude characteristic which compensates an aperture effect which said frequency domain and segment-of-time conversion method or subsequent ones give to said transmission signal.

[0012]Suitably said signal quota means A bit string of two or more of said transmission dataComplex type-type [showing a signal point of said prescribed quadrature modulation method assigned to said each of bit string of two or more of said transmission data] signal point data is matchedit memorizes and said signal point data is outputted according to said each of bit string of two or more of said transmission data inputted.

[0013]A counting circuit which said signal quota means calculates the number of said bit strings of two or more of said transmission data inputtedand supplies these enumerated data to said signal point memory measure suitablyA reset circuit which resets enumerated data of said counting circuit whenever said bit string of 1 set of two or more of said transmission data is inputtedSaid bit string of two or more of said transmission data and enumerated data of said counting means are used as address input datasaid each of signal point data is memorized to a memory address which said each of address input data showsand it has a memory circuit which outputs said signal point data according to said address input data.

[0014]Data transmission equipment concerning this invention transmits N transmission data (N is an integer) which divided a sound and picture image data for television broadcasting into N piecesfor example with an OFDM system. In data transmission equipment concerning this inventiona frequency domain and a segment-of-time conversion methodThe fast Fourier inverse transformation (IFFT) processing of the signal point of quadrature modulation methodssuch as an PSK method which a signal point quota means assigned to 1 set (N pieces) of transmission dataand a QAM methodis carried outand it changes into a segment of

time from a frequency domain it bundles up about all the carrier signals used for transmission and a modulation process is performed.

[0015] A D / A conversion means changes into analog format transmission data of a digital format changed into a segment of time and generates a transmission signal. A D / A conversion means has a predetermined frequency characteristic and an aperture effect is given to a generated transmission signal. A carrier signal of an intermediate frequency band is modulated with a transmission signal which generated an orthogonal modulation means with the above-mentioned quadrature modulation method and when still more nearly required frequency conversion is carried out to carrier frequency of a communication transmission line and it sends out to a communication transmission line.

[0016] After an aperture effect is given to a transmission signal by a D / A conversion means a signal point quota means so that the amplitude characteristic of a transmission signal may carry out flattening into all the transmission frequency bandwidth. It assigns at a signal point which has beforehand the amplitude difference which negates an aperture effect for each N transmission data and equalization processing of a transmission signal is made unnecessary. When an aperture effect given to a modulating signal by each component part communication transmission lines etc. such as an orthogonal modulation means after a D / A conversion means is known beforehand a signal point quota means it assigns at a signal point so that an aperture effect given to a modulating signal by these may be compensated.

[0017] They are two or more transmission data which assigned a data transmission method concerning this invention at a signal point of said prescribed quadrature modulation method was changed into a segment of time from a frequency domain and was changed into analog format. It is a data transmission method of an OFDM system which becomes irregular with a prescribed quadrature modulation method and transmits two or more carrier signals of each of predetermined frequency. Said each of two or more transmission data is assigned at a signal point of said prescribed quadrature modulation method which gave a predetermined amplitude characteristic beforehand so that an aperture effect given to said each of two or more transmission data in the case of said abnormal conditions and transmission may be compensated.

[0018]

[Embodiment of the Invention]

A 1st less than embodiment and a 1st embodiment of this invention are described. Drawing 1 is a figure showing the composition of the data transmission equipment 1 of the QPSK (Quadrature Phase Shift Keying)-OFDM system concerning this invention in a 1st embodiment. As shown in drawing 1 the data transmission equipment 1 The serial/parallel-conversion circuit (S/P conversion circuit) 100 the discrete Fourier inversion circuit (IFFT circuit) 104 of 102 or N points of signal point sending devices (MOD) digital to analog circuit (D/A conversion circuit) 106, 106₂ It comprises lowpass filter circuit (LPF circuit) 108, 108₂ the QPSK modulation circuit 18 the sending circuit 20 and the antenna 126.

[0019]The QPSK modulation circuit 18 comprises analog multiplying circuit 110, the $\pi/2$ phase-shifting circuit 112, the local oscillation circuit (IFLOSC) 114 for intermediate frequencies, the analog adder circuit 116, and the band pass filter circuit 118 for intermediate frequencies (BPF circuit). The sending circuit 20 comprises the analog multiplying circuit 120, the local oscillation circuit (RFLOSC) 122 for transmission frequency bandwidth, and the BPF circuit 124 for transmission frequency.

[0020]For example, when using the data transmission equipment 1 for transmission of the sound and picture image data of digital television broadcast using a terrestrial wave, the sound and picture image data by which compression encoding was carried out with the MPEG system are serially inputted into the data transmission equipment 1 as the input data IN. The data transmission equipment 1 deals with the input data IN as one-piece N 2-bit data corresponding to the signal point of a QPSK modulation method and generates and transmits the modulating signal of the OFDM system which has N carrier signals in transmission frequency bandwidth.

[0021]N transmission data IN_k contained in the input data IN into which the S/P conversion circuit 100 was inputted and I — each is changed into the data of 2 bit parallel forms and is outputted to the signal point sending device 102 as the parallel data S100. Drawing 2 is a figure showing correspondence with the value of transmission data $IN_{k \text{ and } l}$ and the signal point of the QPSK modulation method which the signal point sending device 102 shown in drawing 1 assigns. Corresponding to the value of inputted transmission data IN_k of 2 bit parallel forms and I ($I = 01 \text{---} N-1$) the signal point sending device 102 is assigned to signal point data Z_k of a QPSK modulation method and I as shown in drawing 2 and it is outputted to IFFT circuit 104. Here, signal point data $Z_{k \text{ and } l}$ can be expressed like a lower type.

[0022]

[Equation 1] As for an integer k and l, the real component of signal point data $Z_{k \text{ and } l}$ $Y_{k \text{ and } l}$ of the number of sequences of an OFDM symbol $X_{k \text{ and } l}$ are $[Z_{kl} = X_{kl} + jY_{kl}]$ however k and l, the imaginary components of signal point data $Z_{k \text{ and } l}$.

[0023]In the data transmission equipment 1 as shown in a lower type, the absolute value of signal point data $Z_{k \text{ and } l}$ is constant.

[0024]

[Equation 2] It is $|Z_{k \text{ and } l}| = \text{Const}$ however $\text{Const} > 0$.

[0025]IFFT circuit 104 carries out IFFT processing of 1 set of N piece data [signal point] Z_k inputted from the signal point sending device 102 and the I ($Z_0, Z_1, \text{---}, Z_{N-1}$) N piece 1 set of complex data $z_{k \text{ and } m}$ ($z_0, z_1, \text{---}, z_{N-1}$) are generated. However, the complex data which IFFT circuit 104 outputs is expressed with a lower type.

[0026]

[Equation 3] The real component of complex data $z_{k \text{ and } l}$ $Y_{k \text{ and } l}$ of $z_{kl} = x_{km} + jy_{km}$ however $x_{k \text{ and } l}$ are the imaginary components of complex data $z_{k \text{ and } l}$.

[0027]D/A conversion circuit 106₁ and 106₂ Complex data z_k of a digital format inputted from IFFT circuit 104 respectively, real component x_k of z_k and imaginary component $y_{k \text{ and } m}$ are changed into analog format. It outputs to LPF circuit 108₁ and 108₂ as transmission signal S106₁.

and S106₂. LPF circuit 108₁ and 108₂ remove unnecessary harmonic content of D/A conversion circuit 106₁, transmission signal S106₁ inputted from 106₂ and S106₂ respectively. It outputs to multiplication circuit 110₁ of the QPSK modulation circuit 18 and 110₂ as transmission signal S108₁ and S108₂.

[0028] In the QPSK modulation circuit 18, the local oscillation circuit 114 generates a carrier signal of an intermediate frequency band and outputs it to the multiplication circuit 110₁ and $\pi/2$ phase-shifting circuit 112. A phase of a carrier signal into which the $\pi/2$ phase-shifting circuit 112 was inputted from the local oscillation circuit 114 is $\pi/2$ rad (90 degrees) -- it is delayed and a phase shift is carried out and it multiplication circuit 110₂ receives and outputs. Transmission signal S108₁ into which multiplication circuit 110₁ and 110₂ were inputted from LPF circuit 108₁ and 108₂ respectively and S108₂, a carrier signal inputted from the local oscillation circuit 114 and the local oscillation circuit 114 is $\pi/2$ rad -- the multiplication of the carrier signal by which the phase shift was carried out is carried out in analog and it outputs to the adder circuit 116 as multiplication signal S110₁ and S110₂.

[0029] The adder circuit 116 adds multiplication circuit 110₁, multiplication signal S110₁ inputted from 110₂ and S110₂ and outputs them to the BPF circuit 118 as the modulating signal S116. The BPF circuit 118 removes unwanted signal components other than an intermediate frequency band from the modulating signal S116 inputted from the adder circuit 116. The QPSK modulation circuit 18 modulates a carrier signal of an intermediate frequency band by a QPSK modulation method by such component part, generates the modulating signal S18 and outputs it to the multiplication circuit 120 of the sending circuit 20.

[0030] In the sending circuit 20, the local oscillation circuit 122 generates a carrier signal of frequency which suited a communication transmission line and outputs it to the multiplication circuit 120. The multiplication circuit 120 carries out the multiplication of a carrier signal inputted from the local oscillation circuit 122 and the modulating signal S18 inputted from the QPSK modulation circuit 18 in analog, generates the modulating signal S120 of transmission frequency bandwidth and outputs it to the BPF circuit 124.

[0031] The BPF circuit 124 removes unwanted signal components other than transmission frequency bandwidth from the modulating signal S120 inputted from the multiplication circuit 120. By such component part, the sending circuit 20 changes the modulating signal S18 of an intermediate frequency band into the modulating signal S20 of a carrier frequency zone and sends it out to a communication transmission line via the antenna 126.

[0032] As explained above, the data transmission equipments 1 are N transmission data IN_k which constitutes the input data IN such as a sound, picture, image data, etc. of television broadcasting which carried out compression encoding and |N carrier signals in transmission frequency bandwidth are modulated, the modulating signal S20 of an OFDM system is generated and it distributes to a receiving set of an audience's house.

[0033] Since according to the data transmission equipment 1 concerning this invention, transmission data can be transmitted with a transmission data rate

equivalent to a case where modulation methodssuch as a QAM methodare used and also a transmission data rate per modulating signal can be made lowit is hard to be influenced by a multipass ghost obstacle etc. Thereforethe data transmission equipment 1 is suitable for digital television broadcast which used a terrestrial wave. Since the data transmission equipment 1 performs data communications with an OFDM systemit fits transmission of a SFN method and can exploit frequency resources effectively.

[0034]Although a QPSK method was used for the data transmission equipment 1 in the 1st example as a modulation method in the QPSK modulation circuit 18For exampleby changing the S/P conversion circuit 100 so that 4-bit parallel data may be generatedand changing the signal point sending device 102 so that a signal point of a 16QAM method may be assignedIn the QPSK modulation circuit 18other multiple-value quadrature modulation methodssuch as a 16QAM methodcan also be usedandas for two or more modulation methods and a metaphorit is still more possible in the QPSK modulation circuit 18 to also make a QAM method and an PSK method intermingled.

[0035]Each component part of the data transmission equipment 1 does not ask whether an equivalent function and performance are realized in hardware only in the inside which can be collateralizedor it realizes by software. The data transmission equipment 1 can be used for a use which transmitsother kindsfor exampledata for computersbesides [which transmits a sound and picture image data of a television program] a use.

[0036]A data transmission method in the data transmission equipment 1 is applicable to record of a magnetic recording medium only not only in data transmission equipmentfor example. The data transmission equipment 1 can be used for data communications not only through data communications through a radio transmission line but a wire communication transmission line.

[0037]A 2nd less than embodiment and a 2nd embodiment of this invention are described. Drawing 3 is a figure showing composition of the data transmission equipment 2 of a QPSK-OFDM system concerning this invention in a 2nd embodiment. As shown in drawing 3the data transmission equipment 2 comprises the S/P conversion circuit 100the signal point sending device 14IFFT circuit 16D/A conversion circuit 106₁106₂LPF circuit 108₁108₂the QPSK modulation circuit 18the sending circuit 20and the antenna 126. Same component part and a signal (data) of the data transmission equipment 2 as the data transmission equipment 1 shown in drawing 1 attach the same numeralsand are shown.

[0038]Drawing 4 is a figure showing composition of the signal point sending device 14 shown in drawing 3. As shown in drawing 4the signal point sending device 14 comprises ROM142 and the subcarrier counter circuit 144. The subcarrier counter circuit 144 counts up enumerated datawhenever the parallel data S100 are inputted into the signal point sending device 14. That isthe signal point sending device 14 calculates the subscript l of transmission data $INZ_{k \text{ and } l}$ ($l = 01 \cdots N-1$)and receives ROM142 in the enumerated data S144 ($01 \cdots N-1$; ROM#0 - ROM#N-1 (drawing 5))For exampleit outputs as a high order bit of an address of ROM142and

a ROM table (ROM#0 – ROM#N-1) in the modulating signal S20 memorized by ROM142 for every subcarrier is switched. Enumerated data of the subcarrier counter circuit 144 are reset by the reset signal S16c inputted from IFFT circuit 16 and are set to 0.

[0039] As a high order bit of an address of ROM142 The enumerated data S144 of the subcarrier counter circuit 144 are inputted as mentioned above for example the parallel data S100 inputted from the S/P conversion circuit 100 and the enumerated data S144 of the subcarrier counter circuit 144 are inputted as a lower bit.

[0040] Drawing 5 is a figure showing the contents of signal point data $Z_{k \text{ and } l}$ memorized to an address of ROM142 shown in drawing 4 and 1. An amplitude characteristic (aperture effect) of signal point data $Z_{k \text{ and } l}$ which each portion and communication transmission line such as D/A conversion circuit 106₁ after IFFT circuit 16 and 106₂ give to the modulating signal S20 is sinc. A case where it is expressed with $[k\pi/2N]$ is shown.

[0041] In each address of ROM142 as shown in drawing 5 signal point data $Z_{k \text{ and } l}$ are memorized in the form of a complex number as a ROM table (ROM#0 – ROM#N-1) for every N carrier signals of the modulating signal S20. Here also in the data transmission equipment 2 signal point data $Z_{k \text{ and } l}$ can be expressed like a lower type like a case of the data transmission equipment 1 (drawing 1).

[0042]

[Equation 4] As for an integer and k the real component of signal point data $Z_{k \text{ and } l}$ $Y_{k \text{ and } l}$ of the number of sequences of an OFDM symbol $X_{k \text{ and } l}$ are $[Z_{kl} = X_{kl} + jY_{kl}]$ however k and l the imaginary components of signal point data $Z_{k \text{ and } l}$.

[0043] The absolute value of signal point data $Z_{k \text{ and } l}$ memorized by ROM142 and 1. According to the enumerated data S144 of the subcarrier counter circuit 144 and the value of the parallel data S100 inputted from the S/P conversion circuit 100 The predetermined frequency characteristic is added so that each component part after IFFT circuit 16 and the aperture effect especially given to the modulating signal S20 with D/A conversion circuit 106₁, 106₂ or the frequency characteristic of a communication transmission line measured beforehand may be compensated. As the data transmission equipment 2 is shown in a lower type unlike the data transmission equipment 1 (drawing 1) the absolute value (amplitude average power) of signal point data $Z_{k \text{ and } l}$ is not constant.

[0044]

[Equation 5] $|Z_{kl}| = f(S144S100)$

However $f(S144S100) > 0$ and $f(S144S100)$ are the amplitude of a signal point which becomes settled according to the parallel data S100 and the enumerated data S144.

[0045] IFFT circuit 16 like IFFT circuit 104 of the data transmission equipment 1 (drawing 1) IFFT processing of 1 set of N piece data [signal point] Z_k outputted from the signal point sending device 102 and the $(Z_{k0} Z_{k1} \dots Z_{kN-1})$ is carried out and N piece 1 set of complex data $z_{k \text{ and } m}$ ($z_{k0} z_{k1} \dots z_{kN-1}$) are generated.

[0046] IFFT circuit 16 activates the reset signal S16c whenever N signal point data (1 set) $Z_{k \text{ and } l}$ are inputted from the signal point sending device 14 and it clears the

enumerated data S144 of the subcarrier counter circuit 144 of the signal point sending device 14 zero times. Complex data which IFFT circuit 16 outputs is expressed with a lower type like IFFT circuit 104 of the data transmission equipment 1 (drawing 1).

[0047]

[Equation 6] The real component of complex data z_k and $y_{k \text{ and } l}$ of $z_{kl} = x_{km} + jy_{km}$ however $x_{k \text{ and } l}$ are the imaginary components of complex data z_k and l .

[0048] Hereafter operation of the data transmission equipment 2 is explained. N transmission data IN_k into which the S/P conversion circuit 100 was inputted in serial form and l — each is changed into the parallel data S100 of 2 bit parallel forms. In the signal point sending device 14 the subcarrier counter circuit 144 outputs the enumerated data S144 which show the number of the inputted parallel data S100 as a high order bit of the address of ROM142 and chooses the ROM table (ROM#0 – ROM#N-1) memorized by ROM142.

[0049] The value of the parallel data S100 is inputted into the lower bit of ROM142 and ROM142 outputs signal point data Z_k according to the enumerated data S144 and the parallel data S100 of ROM142 which were shown in drawing 5 and l to it to IFFT circuit 16. IFFT circuit 16 carries out IFFT processing of 1 set of N piece data [signal point] Z_k inputted from the signal point sending device 14 and the $(Z_{k0}Z_{k1} \dots Z_{kN-1})$ N piece 1 set of complex data z_k and m ($z_{k0}z_{k1} \dots z_{kN-1}$) are generated and it outputs to D/A conversion circuit 106₁ and 106₂.

[0050] D/A conversion circuit 106₁, 106₂ and LPF circuit 108₁ and 108₂ Complex data z_k real component x_k [of m] m and imaginary component $y_{k \text{ and } m}$ are changed into analog format respectively unnecessary harmonic content is removed transmission signal S106₁ and S106₂ are generated and it outputs to the QPSK modulation circuit 18.

[0051] With a QPSK modulation method the QPSK modulation circuit 18 modulates a carrier signal of an intermediate frequency band by transmission signal S106₁ and S106₂ generates the modulating signal S18 and outputs it to the sending circuit 20. The sending circuit 20 changes the modulating signal S18 into the modulating signal S20 of a carrier frequency zone and sends it out to a communication transmission line via the antenna 126.

[0052] As stated above the data transmission equipment 2 so that an aperture effect beforehand given to the modulating signal S20 by D/A conversion circuit 106₁, 106₂ or communication transmission line with the signal point sending device 16 may be compensated Since input data IN_k signal point data Z_k which changed amplitude according to l (parallel data S100) and l are assigned flattening of the amplitude characteristic of the modulating signal S20 can be carried out in all the transmission frequency bandwidth without using a filter for equalization etc. Therefore an error rate of input data IN_k reproduced and l can be reduced.

[0053] Since the filter for equalization for equalizing the modulating signal S20 is unnecessary the data transmission equipment 2 has small circuit structure and is low cost. Since the data transmission equipment 2 can assign signal point data Z_k optimized beforehand and l to input data IN_k and l (parallel data S100) it can compensate them for sufficient aperture effect to the modulating signal S20. The change same to the data transmission equipment 1 (drawing 1) shown as a 1st embodiment also to

the data transmission equipment 2 shown as a 2nd embodiment is possible.

[0054]

[Effect of the Invention] According to the data transmission equipment and the data transmission method which start this invention as stated above the quality of the modulating signal generated by an OFDM system can be raised more.

According to the data transmission equipment and the data transmission method concerning this invention the data error rate of the transmission data reproduced from the modulating signal which passed through the communication line can be reduced.

[0055] According to the data transmission equipment and the data transmission method concerning this invention when generating the modulating signal of an OFDM system the aperture effect given to a modulating signal can fully be compensated. According to the data transmission equipment and the data transmission method concerning this invention the modulating signal of the quality OFDM system with which the aperture effect was fully compensated is generable with a device [that it is small and low cost].

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is a figure showing the composition of the data transmission equipment of the QPSK-OFDM system concerning this invention in a 1st embodiment.

[Drawing 2] It is a figure showing correspondence with the value of transmission data IN_k and i and the signal point of the QPSK modulation method which the signal point sending device shown in drawing 1 assigns.

[Drawing 3] It is a figure showing the composition of the data transmission equipment of the QPSK-OFDM system concerning this invention in a 2nd embodiment.

[Drawing 4] It is a figure showing the composition of the signal point sending device shown in drawing 3.

[Drawing 5] It is a figure showing the contents of signal point data Z_k memorized to the

address of ROM shown in drawing 4 and 1*

[Description of Notations]

12 -- Data transmission equipment
100 -- A S/P conversion circuit
102 14 -- Signal point sending device
104 16 -- An IFFT circuit
106₁, 106₂ -- D/A conversion circuit
108 -- A QPSK modulation circuit
108₁, 108₂ -- LPF circuit
110₁, 110₂ [-- An adder circuit
118 / -- A BPF circuit
120 / -- A sending circuit
120 / -- A multiplication circuit
122 / -- A local oscillation circuit
124 / -- A BPF circuit
126 / -- Antenna] -- A multiplication circuit
112 -- pi/2 phase-shifting circuit
114 -- A local oscillation circuit
116
